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New Forms of Gemba Walks and their Digital Tools in the Digital Lean Manufacturing World

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Abstract. Gemba Walks are an important mean of vertical integration in Lean Manufacturing environments. They ensure that all levels of the company stay connected with the front-line, “the Gemba”, where the actual value is created. However, traditionally Gemba Walks have been restricted to one location. This is a shortcoming in production environments characterized by interconnected and often globally dispersed problems where information from several locations is needed simultaneously. In response, this paper explores the emergence of new forms of Gemba Walks enabled by the adoption of new digital technologies. We intend to identify the advantages and disadvantages of using digital technology to support the execution of these new forms of Gemba Walks in more complex, globalized environments and to get a grasp of the extent to which digitalization changes communication characteristics between the parties involved.

Keywords: Digital Manufacturing, Smart Manufacturing, Lean Manufacturing, Digital Lean Manufacturing, Cyber-Physical Production Systems, Industry 4.0, Augmented Reality, Gemba Walks.

1 Introduction

Lean managers agree that it is important for all levels of management to stay connected with the shop-floor, where value is created. An important mean to realize this vertical integration is through *Gemba Walks* [1] [2]. Traditionally, *Gemba Walks* refer to lean managers making an effort to physically “go and see” what is happening on the shop-floor using their human senses to better understand the problems and actual work processes that their employees deal with every day to create value for their customers [1] [2]. However, a managers’ physical presence in their organisations’ front-lines is not helpful unless it enables active problem-solving [3]. The higher the level of management, the higher the control sphere and consequently the more complex the problems to be solved [4]. Contemporary problems are often no longer isolated at the front-line level, where the interconnectedness of problems becomes apparent. To address this properly, several *Gemba Walks* at distant global locations need to be conducted simultaneously.

The emerging *Digital Lean Manufacturing World* builds on “new data acquisition, data integration, data processing and data visualization capabilities to create different descriptive, predictive and prescriptive analytics applications to detect, fix, predict and prevent unstable process parameters and/or avoid quality issues inside defined tolerance ranges that may lead to any type of waste within the cyber- and physical- worlds” [5]. Such capabilities have the promise to support important feedback-loops for continuous improvement cycles [6] as well as managers’ double-loop learning cycles, independent of physical location [7]. This provides an important mean to enhance traditional *Gemba Walks*, making them more suitable for complex, globalized production environments.

In this paper, we explore the emergence of new forms of *Gemba Walks* enabled by the adoption of new *digital technologies* at the digital lean factory floor. We aim to achieve this research goal by analysing innovative technology-based *Gemba Walk* solutions available to the industry. Our aim is twofold, firstly, to identify the advantages and disadvantages of using digital technology to support the implementation of this lean technique, and secondly, to grasp the extent to which *digitalization* changes communication characteristics between the parties involved in a *Gemba Walk*.

The research and assessment methods used were an explorative review of scientific and grey literature and empirical observations by the authors as lean consultants.

2 Gemba Walks

As a combination of *Gemba* (“the real thing”), *Genchi Genbutsu* (“go and see”), and *Genjitsu* (“real facts”), a *Gemba Walk* is a powerful lean technique to observe, interact, gather information, and understand how work or co-work is performed by humans and/or machines. Specifically, it is an important mean for vertical integration that aims to foster the systematic development of an organisation by developing the human potential to solve problems and identify ideas for improvement.

A *Gemba Walk* is characterised by four distinctive elements: (i) *Location* – observing an operator, a machine, or a team at “the actual location” where the work is being performed; (ii) *Observation* – watching an operator, a machine, or a team perform their work “in person”; (iii) *Teaming* – “interacting” with an operator, a machine, or a team performing work by respectfully asking questions, if appropriate; and (iv) *Reflecting* – after “seeing and listening”, on what actions are required to support innovation and continuous improvement [1] [2]. It is specifically this latter part that is important for the success of *Gemba Walks* [2].

Gemba Walks are a core *lean management tool* since they provide an up-close, detailed view of behaviours in action and context, thus facilitating “understanding by seeing”, and the subsequent identification of process improvement opportunities [2]. Moreover, *Gemba Walks* are an important *lean leadership tool* since they enable lean managers to directly engage with the operators at their actual workplace. By performing regular *Gemba Walks*, lean managers show appreciation for the work of the employees in creating value, boosting morale with their presence, and gaining their trust to share relevant information for continuous improvement [8].

In summary, *Gemba Walks* support organisations’ improvement by (i) developing knowledge through the integration and exchange of contextualized information, (ii) supporting managers to make the right decisions that depend on the context in which they are taken, (iii) building *Nemawashi* (“consensus”) by getting people through

observation and discussion to agree on what the main problem is and how it can be addressed, and (iv) improving the organisations' ability to capture the skills of each human resource through direct interaction with people as they face problems. However, people are often bound to one location, which means they can just observe problems within a given physical perimeter. This limits the usefulness of traditional *Gemba Walks* in ever more complex business environments, where problems are interconnected and often globally dispersed. Therefore, *Gemba Walks* should be enhanced to allow for simultaneous visits of several *Gemba*'s or to allow for simple access to information via augmented realities.

2.1 New Forms of Gemba Walks

As the adoption of *Digital Technologies* continues to increase rapidly at the factory floor [5], new forms of *Gemba Walks* are emerging. Such new forms identified in this explorative research work are based on the authors' empirical observations and scientific and grey literature reviews. The identified new forms of *Gemba Walks* are:

Simplified Virtual Gemba Walks – when lean managers may use of hand-held cameras in a remote location to record or transmit their walk live for others.

Augmented Gemba Walks – when lean managers “go to *Gemba*” using wearable technologies [9] such as Augmented Reality (AR) smart glasses. In this new *Gemba Walk* form, lean managers' senses are ‘augmented’ allowing him/her to ‘see and listen’ in real-time and in his/her field of view the emerging big data world of digital lean factory floors loaded with relevant and up-to-date information from IIoT-enabled smart, social machines [10] and operators [11] (e.g. real-time performance data). Such an enriched and detailed big data world improves the context- and situational-awareness of *augmented lean managers* as they walk the shop-floor and engage with the operators and machines. This helps to gain a more accurate understanding of the current problems and makes for more effective continuous improvement measures.

Advanced Virtual Gemba Walks – when lean managers utilize *digital technologies* to ‘remotely interact’ with IIoT-enabled smart, social machines and operators through *digital twins*, in Virtual Reality (VR) production environments. In this new form of *Gemba Walk*, lean managers use virtual and digital copies of the production resources [12], and *VR technologies* for creating immersive VR production environments to conduct *Virtual Gemba Walks* [13] without neglecting the essential context- and situational-awareness of being on the actual shop-floor. In these VR environments, *digital twins* can offer a detailed view of a production system, allowing lean managers to simulate and analyse work processes and view them from different perspectives without any disruption of a production resource. Consequently, this contributes to problem-solving and continuous improvement based on advanced simulations and big data analytics [14].

Automated Guided Gemba Walks – when lean managers' *Gemba Walks* are ‘automated and guided’ by data-driven trend predictions provided by IIoT-enabled smart, social machines and operators at digital lean factory floors. This allows them to anticipate deviations from standard operating procedures (SOPs), production system states, or work processes parameters, and take appropriate preventative actions. In this new form of *Gemba Walks*, *Andon systems* [15] could be used, for example, to guide, and augment the walking path of lean managers, showing areas deserving particular attention by highlighting them, for example, with yellow lights.

Human Cyber-Physical Gemba Walks – when lean managers and AI-enabled systems (i.e. intelligent personal assistants) become ‘joint cognitive systems’ [16] [17]. Both are walking the *Gemba* physically and digitally, correspondingly, the path of production with a critical eye for observing and detecting deviations from standard operating procedures or actual work processes abnormalities. In this new form of *Gemba Walks*, humans make use of their (augmented) senses and cognition while the AIs use their network of sensors available in a digital lean factory floor combined with different data analytics tools (e.g. event-driven, real-time data-driven, and trend prediction) for sensemaking (i.e. 5 Whys) of such deviations or abnormalities. Humans and AIs interact in a meaningful way as a joint cognitive system to investigate and understand the root cause of problems.

2.2 New Digital Tools for New Forms of Gemba Walks

Supporting lean managers as they “go to *Gemba*”, and observe, ask why, take notes, and show respect for people in the *Digital Lean Enterprise*, calls for a new set of digital tools for data collection, sharing, analysis, optimization, and feedback. For *data collection support*, handheld-devices such as tablets and smartphones, equipped with a variety of sensors, will allow the easy-capture of text, images, audio, video, indoor locations, and other measures (e.g. temperature, light, vibrations, etc.). The richness of data in digitally-documented observations will lead to better decision-support and decision-making.

Moreover, for *data sharing support* in information systems, ‘tags’ as metadata can be utilized to describe a data item and facilitate its categorization, and later search in a database. Tagging and push-information systems can help to guarantee that the right person(s) and/or system(s) will receive the right data for its further processing.

Furthermore, for *data analysis support*, visual analytics tools [18] offer various interactive visualization techniques (i.e. visual data exploration) to support human analytical reasoning for data-driven decision-making. Visual Analytics tools emerge to be indispensable at the big data digital lean factory floors with its ability to generate data at a faster rate than it can be analysed by humans without support.

For *data optimization support*, automatic data analysis tools [19] (e.g. data mining, machine learning) will support the automated filtering, categorization, and analysis of massive and complex datasets that are manually unfeasible in big data digital lean factories. Automatic data analysis tools will help human analysts to generate, evaluate, and refine their data-driven decision models to support their decision-making.

Lastly, for *data feedback support*, virtual *Obeya* rooms [20] can offer person-to-person communication, sharing each other’s notes, posting and reading posts, and updating data and events as new things happen. Virtual *Obeya* can help to speed-up feedback cycles for action-taking and continuous improvement by overcoming the boundaries of time and space of traditional *Obeya* rooms.

3 Assessing the New Forms of Gemba Walks

Taking into account the critical elements, or dimensions, of the *Gemba Walk* definition, we can characterize the new forms of *Gemba Walks* as reported in Figure 1.

Concerning *Location*, the introduction of digital technologies may allow the observer to avoid being physically present in the place where the value is generated by intervening

remotely. This possibility provides the observer greater accessibility in time and space to the *Gemba*, thus allowing more opportunities for gaining knowledge of the context and the problem of how resources operate by exploiting their skills. The result is a greater opportunity to capture the capabilities of individuals and multiple opportunities to find the right answers and solutions for improvement.

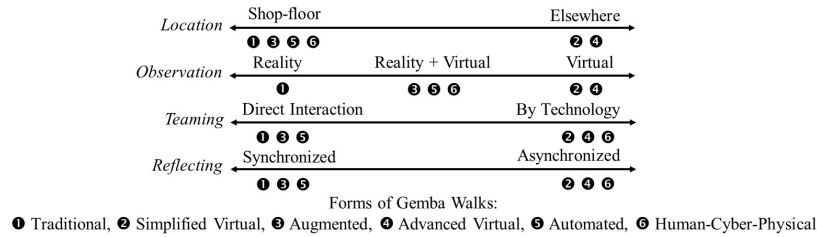


Fig. 1. Main Characteristics of the New Forms of Gemba Walks

If we refer instead to the way *Observation* takes place, thanks to the use of digital technology it is possible to move from a physical to a virtual perspective, operating in an environment where it is easier to experiment with proposals for improvement even anticipating the behaviour of a productive resource. Where instead there is the possibility of integrating the physical environment with the digital one, with the use of augmented reality, it is possible to obtain more details and information from the field to better understand the context being analysed and therefore make better decisions.

Moreover, the use of technology, with respect to *Teaming*, allows modifying the approach of identifying and sharing information through disintermediation between the supplier and the receiver. If the separation between the parties increases the time available to deal with and solve problems and increases the opportunities to understand the capabilities of each resource, at the same time it reduces the moments of contact making it more complicated for the parties to create an environment of mutual trust.

Finally, as far as *Reflection* is concerned, thanks to the use of new technologies, the logic of analysis of the problem and solutions changes, as technological innovations make possible to study the behaviour of a system or resource, not necessarily at the moment in which it operates. The advantage lies in the possibility of integrating human experience with the speed and flexibility of technology to create better solutions with the risk of relying too much on artificial intelligence, instead of people’s knowledge and skills.

The consequent advantages and disadvantages of the new forms of *Gemba Walks* for supporting lean managers double-loop learning cycles are summarised in Table 1.

Table 1. New Forms of Gemba Walks: Advantages and Disadvantages

Forms of Gemba Walks	Advantages	Disadvantages
Traditional	<ul style="list-style-type: none"> Aligning perception with reality. First-hand facts and data. Direct interaction with employees and equipment. 	<ul style="list-style-type: none"> Limit time to ask “why” so to not disrupt the continuous flow. Potential narrow view.

Simplified Virtual	<ul style="list-style-type: none"> • Seeing and hearing remotely. 	<ul style="list-style-type: none"> • Other senses excluded.
Augmented	<ul style="list-style-type: none"> • Adding detailed data to remove subjectivity. • Better observations mean better decisions. 	<ul style="list-style-type: none"> • Putting more attention to data over people thoughts.
Advanced Virtual	<ul style="list-style-type: none"> • Learning from reality and possible future scenarios. 	<ul style="list-style-type: none"> • Indirect interaction with employees and equipment.
Automated Guided	<ul style="list-style-type: none"> • Being proactive towards detected (negative) trends. 	<ul style="list-style-type: none"> • Parts of the processes chains may be skipped.
Human Cyber-Physical	<ul style="list-style-type: none"> • Learning together humans and AI systems, thus accelerating learning. 	<ul style="list-style-type: none"> • Relying too much on AI systems, instead of people knowledge and skills.

4 Effects on Communication & Feedback

As digital lean factory floors start hosting more cyber-physical productions systems, “going to *Gemba*” will become a “data-driven” continuous improvement effort for the case of *Gemba Kaizen* initiatives (i.e. incremental, exploitative improvement efforts), and will remain more “human-driven” for the case of *Gemba Kaikaku* initiatives (i.e. radical, explorative improvements efforts). Although automation technologies could be seen as more advanced than human-centred ones, there are some complex and special tasks that only humans can accomplish (see [21]).

The effectiveness of the new forms of *Gemba Walks* for enabling continuous improvement and double-loop learning is based on the quality of the feedback loops. Such quality can be measured according to the feedback-loops properties of (Ci) *Completeness* – as their effectiveness to identify and communicate all “observations” needed to understand the ideas, advice, complaints, and issues detected and collected during a *Gemba Walk*; (Cii) *Conciseness* – as their effectiveness to organise and present the proper amount of information, and avoid information overload (i.e. cognitive *Muri*), in support of agile decision-making; (Ciii) *Consideration* – as their effectiveness to recognize, value, and combine different data-sources coming humans and computer information systems to support an integrated decision-making; (Civ) *Concreteness* – as their effectiveness to call for action based on clear instructions for problem-solving or performance improvement; (Cv) *Courtesy* – as their effectiveness for offering “respect for people” when it comes to negotiating and agreeing to a change or modification in work and/or behaviour; (Cvi) *Clarity* – as their effectiveness to provide clear evidence and justification for the needed change or modification for improvement; and (Cvii) *Correctness* – as their effectiveness to create a positive impact with the change or modification in the processes and people (see Table 2).

Regarding the distinctive features of the new forms of *Gemba Walks*, we can state that the *Completeness* is higher where it is possible to integrate both physical and virtual reality making the “observation” more extensive. From this point of view operating in a virtual context remains completely indifferent concerning a real context. Indeed, if the “observation” carried out in a virtual reality environment can be extended in time and space, operating from external place involves the risk of a lower ability to capture the characteristics of the context where the information is generated. Another risk of virtualization is evident regarding *Conciseness*. The excessive use of technology to

support data observation and analysis can create conditions of information overload, thus falling into the trap of *Muda* or digital waste [5] [22]. Moreover, if the shift of perspective towards a virtual world favours the possibility of combining information from different sources (i.e. *Consideration*), on the other hand, excessive virtualization leads to disintermediation between subjects, thus losing communicative effectiveness. This principle also applies to *Courtesy*, understood as the ability to create collaboration and mutual trust between people, which inevitably disappears by shifting the focus of the decision-making process from people to machines. The *Concreteness*, *Clarity*, and *Correctness* of information are potentially higher in a virtual context, as the use of digital information and technologies allows to capture more detailed information and to reprocess it faster to propose better solutions. However, reducing the participation of actors in the process of problem analysis and processing of results risks harming the final effectiveness of the actions undertaken, as the proposed solution is not made by those who have to implement it. Based on these considerations, Table 2 summarizes the relations between the components of the communication and new types of *Gemba Walks*. The evaluation is made with reference (REF) to the traditional *Gemba Walk*.

Table 2. New Forms of Gemba Walks: Effects on Communication & Feedback Characteristics

Forms of Gemba Walks	Ci	Cii	Ciii	Civ	Cv	Cvi	Cvii
Traditional	REF	REF	REF	REF	REF	REF	REF
Simplified Virtual	=	=	-	+	-	-	=
Augmented	+	+	=	+	=	=	=
Advanced Virtual	=	+	+	+	-	+	=
Automated Guided	+	+	+	+	-	+	=
Human Cyber-Physical	+	+	=	+	-	+	=

+: Higher Impact

=: Same Impact

-: Lower Impact

5 Conclusions & Outlook

The success of *Gemba Walks* depends on their capability to enable active problem-solving. Nevertheless, traditionally *Gemba Walks* are bound to one location and current information. This is ill-suited in a production environment where problems are complex, interconnected and often globally dispersed. The new, technology-enhanced forms of *Gemba Walks*, presented in this paper, can bring great benefits for innovation, problem-solving, and continuous improvement of conditions, tools, and procedures at the factory floor in these contexts. They allow to bridge time and space and if used correctly, increase the opportunity to observe operations within our globalized world greatly. However, lean managers must ensure that these new forms do not hinder the main goal of *Gemba Walks* of communicating and collaborating with the operators in their terms, and at their locations. The new technology-enhanced forms of *Gemba Walks* may be perceived as ‘policing’ (a.k.a. “big brother” is watching you) and thus contradict its original intentions. Lean managers should always show “respect for people” by visiting their operators at their workplace, and keep in mind that their creativity, ingenuity, and innovation, as well as daily standardized work (i.e. standard operating procedures), are the true sources of sustained value-creation, continuous improvement, and operational excellence. Outlook – *Genchi-Genbutsu* practice is being revised by Toyota [see 23].

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